Project:	**14NO114CA – Red River Supply**
Location:	**Williston, ND**
Client:	**Garner Environmental**
Version History:	**1.1**

Air Monitoring and Sampling Strategy

The strategy is to monitor potential exposures in three broadly defined areas: Work Area, Perimeter, and Community. The Work Area may be designated as the area directly surrounding the incident site and occupied by workers actively or sporadically involved in remediation and/or normal work activities. The Perimeter may be designated as the boundary of the facility. The Community may be designated as the area immediately surrounding the Perimeter, including residential and commercial locations where there is a potential for exposure to chemicals.

Air monitoring involves the use of direct reading air monitors such as photoionization detectors, chemical specific sensors, and colorimetric detector tubes. Free-roaming handheld real-time air monitoring may be conducted in a variety of areas based on levels of activity, proximity to the release, and site conditions. Fixed-location handheld real-time locations may be established in the community in order to provide concentration information that may be observed and analyzed over time in distinct geographic locations in the community. Frequency of monitoring for specific analytes may vary based on changing site conditions.

Radio-telemeting RAE Systems® AreaRAE units may be deployed in all sampling zones to allow for continuous air monitoring in multiple areas. AreaRAE readings may be received and monitored in a centralized location by CTEH® personnel to allow for recognition, communication, and response to changing conditions.

Air sampling involves collecting air samples in special containers to be sent to an off-site laboratory for chemical analysis. Air samples may be collected in all three areas. These analytical air samples may be used to provide air quality data beyond the scope of real-time instruments. When necessary, air samples may be collected on individual workers to provide exposure data over the course of a work shift for more direct comparison to occupational exposure values.

Specific chemicals of interest, and monitoring and sampling procedures may be developed upon further inspection of the site.

CTEH Site-Specific Action Levels

CTEH® site-specific action levels may be employed in all sampling zones to provide information for corrective action to limit exposure. These values do not replace occupational or community exposure standards or guidelines, but are intended to be a concentration limit that triggers a course of action to better address worker and public safety. CTEH is focusing on the chemicals chosen below because they may have been released in this incident and they may be released from fires, and at elevated concentrations, could potentially cause adverse health effects.

Plan/Assignment: **WORK AREA**
Assessment areas: 1) Facility perimeter; 2) Frac Tank area;

Objective: Report air levels before they reach those requiring respiratory protection

Analyte	Plan	Action Level	Basis	Action to be Taken
Total VOCs	Work	30 ppm	1/10 TLV for Gasoline - Reading	Report reading to Site Management, assess

	Area		sustained for 15 minutes	work practices.
Benzene	Work Area	0.5 ppm	OSHA PEL Action level – Reading sustained for 15 minutes	Evacuate Area or don air purifying respirator; report reading to Site Management.
Ammonia	Work Area	25 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Ammonia	Work Area	35 ppm	½ ACGIH® STEL – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Hydrogen Sulfide	Work Area	1 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Evacuate Area, report reading to Site Management.
Amines	Work Area	1 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Evacuate Area, report reading to Site Management.
Hydrogen Chloride	Work Area	1 ppm	½ ACGIH® Ceiling – Reading sustained for 15 minutes	Evacuate Area, report reading to Site Management.
Combustion Products				
Particulate Matter ($PM_{2.5}$ or PM_{10})*	Work Area	352 - 526 µg/m^3	Wildfire Smoke Guidelines for 1 -3 hr avg. Very Unhealthy AQI	Report reading to Site Management, If PM level is projected to remain high for a prolonged time, consider evacuation of sensitive populations
Carbon monoxide	Work Area	25 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Carbon dioxide	Work Area	5,000 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Sulfur dioxide	Work Area	0.1 ppm	½ ACGIH® STEL – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Sulfur dioxide	Work Area	0.2 ppm	ACGIH® STEL – Reading sustained for 10 minutes	Evacuate area - Report reading to Site Management.
Nitrogen dioxide	Work Area	0.2 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Nitric oxide	Work Area	25 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Formaldehyde	Work Area	0.15 ppm	½ ACGIH® Ceiling – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Formaldehyde	Work Area	0.3 ppm	ACGIH® Ceiling – Reading sustained for 1 minute	Evacuate area - Report reading to Site Management.
Acetaldehyde	Work Area	12 ppm	½ ACGIH® Ceiling – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.

*$PM_{2.5}$ is especially prone to interference from high humidity, in cases of high humidity use PM_{10} impactor which is not as sensitive to humidity. In general, utilize correction factors to adjust for humidity for PM readings.

Plan/Assignment: **PERIMETER**

Objective: Report air levels before they reach those requiring off site response

Analyte	Plan	Action Level	Basis	Action to be Taken
Total VOCs	Work Area	1 ppm	AIHA recommendation - Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.

Benzene	Work Area	0.5 ppm	OSHA PEL Action level – Reading sustained for 15 minutes	Evacuate Area or don air purifying respirator; report reading to Site Management.
Ammonia	Work Area	25 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Ammonia	Work Area	35 ppm	½ ACGIH® STEL – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Hydrogen Sulfide	Work Area	1 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Evacuate Area, report reading to Site Management.
Amines	Work Area	1 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Evacuate Area, report reading to Site Management.
Hydrogen Chloride	Work Area	1 ppm	½ ACGIH® Ceiling – Reading sustained for 15 minutes	Evacuate Area, report reading to Site Management.
Combustion Products				
Particulate Matter ($PM_{2.5}$ or PM_{10})*	Work Area	352 - 526 µg/m^3	Wildfire Smoke Guidelines for 1 -3 hr avg. Very Unhealthy AQI	Report reading to Site Management, If PM level is projected to remain high for a prolonged time, consider evacuation of sensitive populations
Carbon monoxide	Work Area	25 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Carbon dioxide	Work Area	5,000 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Sulfur dioxide	Work Area	0.1 ppm	½ ACGIH® STEL – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Sulfur dioxide	Work Area	0.2 ppm	ACGIH® STEL – Reading sustained for 10 minutes	Evacuate area - Report reading to Site Management.
Nitrogen dioxide	Work Area	0.2 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Nitric oxide	Work Area	25 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Formaldehyde	Work Area	0.15 ppm	½ ACGIH® Ceiling – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Formaldehyde	Work Area	0.3 ppm	ACGIH® Ceiling – Reading sustained for 1 minute	Evacuate area - Report reading to Site Management.
Acetaldehyde	Work Area	12 ppm	½ ACGIH® Ceiling – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.

*$PM_{2.5}$ is especially prone to interference from high humidity, in cases of high humidity use PM_{10} impactor which is not as sensitive to humidity. In general, utilize correction factors to adjust for humidity for PM readings.

Plan/Assignment: **COMMUNITY**

Objective: Report levels that minimize nuisance levels in the community

Analyte	Plan	Action Level	Basis	Action to be Taken
Total VOCs	Comm.	1 ppm	AIHA recommendation - Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.

Benzene	Comm.	Detect	OSHA PEL Action level – Reading sustained for 15 minutes	Report reading to Site Management.
Ammonia	Comm.	1 ppm	Odor threshold	Report reading to Site Management, assess work practices.
Hydrogen Sulfide	Comm.	Detection	Instrument detection limit	Report reading to Project Technical Director
Amines	Comm.	Detection	Instrument detection limit	Report reading to Project Technical Director
Hydrogen Chloride	Comm.	Detection	Instrument detection limit	Report reading to Project Technical Director
Combustion Products				
Particulate Matter (PM 2.5 or PM10)*	Comm.	39 - 88 $\mu g/m^3$	Wildfire Smoke Guidelines for 1 -3 hr avg. Moderate AQI	Report reading to Site Management, evaluate work practices, Distribute information about exposure avoidance.
Particulate Matter (PM 2.5 or PM10)*	Comm.	89 - 138 $\mu g/m^3$	Wildfire Smoke Guidelines for 1 -3 hr avg. **Unhealthy for Sensitive Groups**	Report reading to Site Management, if smoke event projected to be prolonged notify possible sites for cleaner air shelters.
Carbon monoxide	Comm.	12 ppm	½ ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Carbon dioxide	Comm.	2,500 ppm	½ ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Sulfur dioxide	Comm.	0.05 ppm	1/4 ACGIH® STEL – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Nitrogen dioxide	Comm.	0.1 ppm	½ ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Nitric oxide	Comm.	12 ppm	½ ACGIH® TLV – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Formaldehyde	Comm.	0.15 ppm	½ ACGIH® Ceiling – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.
Acetaldehyde	Comm.	6 ppm	1/4 ACGIH® Ceiling – Reading sustained for 15 minutes	Report reading to Site Management, assess work practices.

*$PM_{2.5}$ is especially prone to interference from high humidity, in cases of high humidity use PM_{10} impactor which is not as sensitive to humidity. In general, utilize correction factors to adjust for humidity for PM readings.

Plan: **All – FLAMMABILITY**

Objective: Report areas where flammability is most likely

Analyte	Instrument Reading	Corrected Value	Correction Factor	Basis	Action to be Taken
LEL	1 %	1 %	NA	1% LEL Sustained 1-5 minutes	Notify Site Management

*Rough estimate based on common crude oil volatiles

Methods

Real-Time Methods					
Chemical	Instrument	Detection Limit	Tube#/Lamp	Notes	Correction Factor
VOC	MultiRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 1 – 5,000	NA
	AreaRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 1 – 5,000	NA
Benzene	UltraRAE	0.05 ppm	PID 9.8 eV lamp	Change SEP tube frequently	0.55
	MultiRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 1 – 5,000	0.53
	AreaRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 1 – 5,000	0.53
	Colorimetric	0.05 ppm	Gastec tube #121L	Range: 0.1 to 10 Volume: 500 ml	1
Ammonia	MultiRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 1 – 5,000	0.5
	AreaRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 1 – 5,000	0.5
	Colorimetric	2 ppm	Gastec tube #3M	Range: 10 to 50 Volume: 200 ml	1/2
Amines	Colorimetric	0.1 ppm	Gastec tube #180L	Range: 0.25 to 39 Volume: 100 ml	Var
Hydrogen Sulfide	MultiRAE	1 ppm	Sensor	Measuring range: 0 – 100 ppm	
	AreaRAE	1 ppm	Sensor	Measuring range: 0 – 100 ppm	
	MultiRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 0 – 100 ppm	3.3
	AreaRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 0 – 100 ppm	3.3
	MultiRAE Pro	0.1 ppm	Sensor	Measuring range: 0.1 – 100 ppm	
	Colorimetric	0.1 ppm	Gastec tube #4LL	Range:0.25 to 2.5 Volume: 1,000 ml	1/10
Hydrogen Chloride	Colorimetric	0.05	Gastec tube #14L	Range:0.2 to 5 Volume: 500 ml	1/5
LEL	MultiRAE	1 %	Sensor	Measuring range: 1 – 100%	NA
	AreaRAE	1 %	Sensor	Measuring range: 1 – 100%	NA
Combustion Products					
PM2.5	SidePak AM510	0.001 mg/m^3	670 nm Laser diode	PM2.5 impactor – 50% cut-off at 2.5 micron PM10 impactor – 50% cut-off at 10 micron	NA
Carbon monoxide	MultiRAE	1 ppm	Sensor	Range: 0 – 500 ppm	
	Colorimetric	0.5 ppm	Gastec tube #1LC	Range: 1 – 30 ppm Volume: 100 ml	1
Sulfur dioxide	MultiRAE	0.1 ppm	Sensor	Range: 0 – 20 ppm	
	Colorimetric	0.05 ppm	Gastec tube #5Lb	Range: 0.05 – 30 ppm Volume: 800 ml	1/4
Nitrogen dioxide	MultiRAE	1 ppm	PID 10.6 eV lamp	Measuring range: 1 – 5,000	16
	MultiRAE	0.1 ppm	Sensor	Range: 0 – 20 ppm	
	Colorimetric	0.1 ppm	Gastec tube #9L	Range: 0.5 – 0.1 ppm Volume: 200 ml	1
Nitric Oxide	Colorimetric	1 ppm	Gastec tube #10	Range: 2.5 – 5 ppm Volume: 200 ml	1/2
Formaldehyde	Colorimetric	0.05 ppm	Gastec tube #91L	Range: 0.1 – 5 ppm Volume: 500 ml	1
Acetaldehyde	Colorimetric	0.25 ppm	Gastec tube #92M	Range: 5 – 100 ppm Volume: 100 ml	1

Analytical Methods				
Analyte	Media/Can	Method	Detection Limit	Target compounds

VOCs	Mini - Cans	EPA TO-15 with TICs	Compare to appropriate health based exposure limit	Benzene, Toluene, m,p-Xylene, 4-Ethyltoluene, 1,2,4-trimethylbenzene, 1,2,5-trimethylbenzene, Methyl-cyclopentane, Cyclohexane, Pentane, Hexane, Heptane, Octane, Decane, Pentane, Hexane, 2-methyl-butane
Aldehydes	DNPH Silica Gel , Assay PM (preferred)	NIOSH 2016	See target compounds	Acetaldehyde 0.1µ, 0.2µg Benzaldehyde 0.1µ, 0.2µg Crotonaldehyde 0.1µ, 0.2µg Formaldehyde 0.1µ, 0.1µg Isovaleraldehyde 0.1µ, 0.2µg n-Butyraldehyde 0.1µ, 0.2µg Propionaldehyde 0.1µ, 0.2µg Valeraldehyde 0.1µ, 0.2µ
Metals	37MCEF 0.8	Mod.NIOSH 7300/Mod.OSHA 125G	See target compounds	Aluminum 7.5µg Antimony 0.9µg Arsenic 0.3µg , 0.15µg Barium 0.15µg, 0.075µg Beryllium 0.15µg, 0.0075µg Cadmium 0.15µg, 0.015µg Calcium 75µg Chromium 3.0µg Cobalt 0.45µg, 0.045µg Copper 0.3µg Iron Oxide 11µg Lead 0.38µg, 0.075µg Magnesium 7.5µg Manganese 0.15µg Nickel 0.3µg, 0.15µg Potassium 15µg Selenium 2.3µg Sodium 75µg Thallium 1.5µg,0.75µg Vanadium 0.45µg Zinc Oxide 2.8µg

SO_2	Treated Filter	Modified NIOSH 6004	10µg	
BTEX (+Hexane)	3M 3520 Badge	Modified NIOSH 1500/1501	Compare to appropriate health based exposure limit	Benzene, Toluene, Ethylbenzene, Xylene, **Hexane**.
PAHs (18 PNAH Profile - Galson)	37PTFE 2.0/Treated Amberlite XAD-2	Method 5506	See target compounds	Benzo(a)anthracene – 6.4 mg/m^3, Benzo(a)pyrene – 0.64 mg/m^3; Benzo(b)fluoranthene – 6.4 mg/m^3; Benzo(k)fluoranthene – 6.4 mg/m^3; Chrysene – 64 mg/m^3; Dibenzo(a,h)anthracene – 0.58 mg/m^3; Indeno(1,2,3-cd)pyrene – 6.4 mg/m^3; Naphthalene – 30 mg/m^3

General Information on Procedures (Assessment Techniques) Used

Procedure	Description
Guardian Network	A Guardian network may be established with AreaRAEs equipped with electrochemical sensors will be positioned at established locations around the work zone. The AreaRAEs will be telemetering instantaneous data at 15-second intervals to a computer console. MultiRAE Pros may also be used in the network. The data will be visible in real-time at the computer console and will be monitored 24 hours per day by CTEH personnel.
Hand-held Survey	CTEH staff members may utilize handheld instruments (e.g. MultiRAE Plus; ppbRAE, Gastec colorimetric detector tubes, etc.) to measure airborne chemical concentrations. CTEH will use these hand-held instruments primarily to measure the breathing zone. Additionally, measurements can be made at grade level, as well as in elevated workspaces, as indicated by chemical properties or site conditions. CTEH may also use

	these techniques to verify detections observed by the AreaRAE network.
Fixed Real-Time Monitoring locations	Multiple community locations may be identified and monitored at the same location approximately once per hour using hand-held instruments. This allows use statistical analysis more effectively than with a random approach.
Analytical sampling	Analytical sampling may be used to validate the fixed station and hand-held data monitoring data, or to provide data beyond the scope of the real-time instruments. Analytical samples may be collected as whole air samples in evacuated canisters or on specific collection media, and sent to an off-site laboratory for further chemical analysis.

Sampling Areas

Sampling Area	Description
Work Area	The Work Area may be designated as the area directly surrounding the incident site and occupied by workers actively or sporadically involved in remediation and/or normal work activities.
	Facility Perimeter
	Frack Tank Area
Hot Zone	The spill area within the Work Area where all major spill cleanup operations will be performed. Generally requiring a level of personal protection above that required in the general work area.
Community	The area immediately surrounding the Work Area, including residential and commercial locations where there is a potential for exposure.
Other	During the course of the remediation, some additional areas or specific tasks may require a unique set of action levels or sampling (e.g. decontamination zones, commercial zones, etc.)

Quality Assurance/Quality Control Procedures

Method	Procedure
Real-time	• Real time instruments may be calibrated in excess of the manufacturer's recommendations. ○ At a minimum whenever indicated by site conditions or instrument readings. • Co-located sampling for analytical analysis may be conducted, if necessary, to assess accuracy and precision in the field. • Lot numbers and expiration dates may be recorded with use of Gastec colorimetric tubes.
Analytical	• Chain of custody documents may be completed for each sample. • Level IV data validation may be performed on the first sample group analyzed. • Level II data validation may be performed on 20% of all samples. • Level IV data validation may be performed on 10% of all samples.
Other	

Version 1.0			
	Name/Organization	Signature	Date Signed
Prepared by:	David Cawthon / CTEH	David Cawthon	7/23/14
Reviewed by:			
Approved by:			
Approved by:			
Approved by:			
Approved by			
Approved by			

Change from version 1.0 to 1.1

- *Project title changed*
- *Assessment areas added*
- *Details added to analytical methods*

	Name/Organization	Signature	Date Signed
Prepared by:	David Cawthon / CTEH	David Cawthon	7/23/14
Review by:			
Approved by:			
Approved by:			
Approved by:			
Approved by			
Approved by			